

REMARKS

Claims 30 to 88 are pending in the application; claims 52-85 and 87-88 are withdrawn.

Rejection under 35 U.S.C. 103

Claims 30 to 43, 45 to 49, and 86 stand rejected under 35 U.S.C. 103(a) as being unpatentable over *Heinrich et al.* (US 5,992,546).

Claims 44, 50, and 51 stand rejected under 35 U.S.C. 103(a) as being unpatentable over *Heinrich et al.* (US 5,992,546) and *Brandrup-Wognesen* (US 5,723,177).

The major objective of the instant patent application is to improve both mechanical and performance properties of cemented carbides on the basis of WC by reinforcing their binder phase. This is achieved by substantially **decreasing the carbon content** in the cemented carbides **leading to significantly higher concentration of tungsten dissolved** in the binder that is based on cobalt or cobalt/nickel.

It is well known (see *B. Roebuck*, Magnetic Moment (Saturation) Measurements on Hardmetals, Int. J. Refractory Met. Hard Mater. 14 (1996) 419-424) that the magnetic saturation of the cemented carbide binder and consequently of the cemented carbide itself is a measure of the amount of tungsten dissolved in the binder in cemented carbide containing a certain percentage of cobalt. *Roebuck* states that the amount of tungsten dissolved in the cobalt binder phase can be assessed by measuring the magnetic saturation/magnetic moment because the saturation value of cobalt decreases with addition of tungsten (compare page 419, right column, lines 7 and 14, of *Roebuck* - see also discussion in the specification, paragraph bridging pages 1 and 2).

It is also well known that in cemented carbides the tungsten contents dissolved in the binder increases significantly as the carbon contents decreases (see *Cho et al.*, The Influence of Carbon Content on the Properties of Binder and Carbide Phase of Cemented Carbide, Interceram. 48 (1999) 30-35 - see Abstract; *Andren*, Microstructures of Cemented Carbides, Material and Design 22 (2001) 491-498 - see page 493, heading "3. WC-Co"). As a result of the decreased carbon content in cemented carbide and the thus increased content of tungsten dissolved in its binder, magnetic saturation of cemented carbide noticeably decreases.

The inventors have surprisingly found that cemented carbides in which the carbon contents is low and the binder has high concentrations of dissolved tungsten metal (and consequently low values of magnetic saturation) provide a dramatic increase in wear resistance, transverse rupture strength and performance toughness. This effect can be achieved only in relatively coarse cemented carbides with thick binder interlayers between WC grains; relatively low values of cemented carbide coercive field strength (below 17.0 kA/m) are characteristic for such materials.

Furthermore, it has been surprisingly found that if the cemented carbide binder comprises nanoparticles of one or several phases of ordered phases of tungsten, cobalt, and/or carbon (see claim 35), the cemented carbide properties can be further dramatically improved. Moreover, if the binder of cemented carbide comprises at least 5 volume % nanoparticles of ordered phases of tungsten, cobalt, and/or carbon, very positive effects on the cemented carbide properties are observed.

Thus, the examiner's assertion that the cemented carbides of the invention are prima facie "identical in structure and composition" to the cemented carbide disclosed in U.S. 5,992,546 is incorrect. Moreover, the assertion that, prima facie, the same values of coercive field strength and magnetic saturation are to be expected is incorrect.

The binder of the cemented carbides of the present invention contain significantly less carbon and consequently much more dissolved tungsten than conventional cemented carbides such as those of *Heinrich et al.* The inventive binders comprise Co interlayers of certain thicknesses as reflected by the claimed range of coercive field strength as indicated by the low values of magnetic saturation of the cemented carbides of the present invention as claimed in claim 30.

Examples 1, 3 and 4 of the present invention disclose magnetic saturation values $4\pi\sigma = 7.0$; 14.8; and $9.4 \mu\text{Tm}^3/\text{kg}$, respectively, for WC-Co hard metal (6.5 % by weight and 9.5 % by weight of Co) with low carbon contents in accordance with the present invention.

The magnetic saturation of the cemented carbides with 4.5 % Co according to U.S. 5,992,546 (Tables 1 and 2) is equal to $17.8 \mu\text{Tm}^3/\text{kg}$ and the magnetic moment δ is equal to $1.42 \mu\text{Tm}^3/\text{kg}$ at 18 Oe or 1.42 kA/m (Table 2). However, a Co contents of 4.5 % by weight in accordance with the range provided in claim 30 (X = Co contents)

should be as follows:

lower value $0.44 \pi X = 6.217 \mu\text{Tm}^3/\text{kg}$

upper value $0.548 \pi X = 7.743 \mu\text{Tm}^3/\text{kg}$

and the magnetic moment σ should be 0.495 to $0.617 \mu\text{Tm}^3/\text{kg}$.

The values of magnetic saturation of the cemented carbide with 4.5 % Co in the range of 6.22 to $7.743 \mu\text{Tm}^3/\text{kg}$ and the magnetic moment σ from 0.495 to $0.617 \mu\text{Tm}^3/\text{kg}$ in accordance with the present invention are significantly lower than the values disclosed in U.S. 5,992,546. The actual value of *Heinrich et al.* of **17.8 of magnetic saturation is more than 2.5 times as high** as the range claimed in claim 30. Note that the examples 1, 3, 4 provided in the specification also have comparative WC-Co materials of the same Co content but higher carbon content; all comparative materials with high carbon contents have much higher magnetic saturation in comparison to the materials of the present invention.

It is therefore clearly evidenced by the greatly differing values that the concentration of **tungsten dissolved in the binder according to the present invention is significantly higher than that of the cemented carbides disclosed in U.S. 5,992,546**. The structure and composition according to the present invention are therefore different and not obvious in view of *Heinrich et al.*

The binder of the cemented carbides of the invention can additionally comprise nanoparticles of ordered phases of tungsten, cobalt, and/or carbon (claim 35) which is clearly indicated by TEM results (transmission electron microscope; see page 7, 1st paragraph; see page 9, 4th paragraph, of the specification) so that the microstructure and nanostructure of the cemented carbides of the present invention is completely different from that described in U.S. 5,992,546.

The prior art reference *Heinrich et al.* therefore does not make obvious the present invention as claimed.

The claims 44, 50, and 51 depend from claim 30 describing cemented carbides with a certain combination of Co content, coercive field strength, and magnetic saturation; such a combination of features is not disclosed in *Heinrich et al.* and *Brandrup-Wognsen* is silent in regard to these features. Claim 35 discloses the

presence of nanoparticles of ordered phase of W, Co and/or carbon in the binder; such nanoparticles are neither disclosed in U.S. 5,992,546 nor U.S. 5,723,177.

The claims 30-51 and 86 are therefore not obvious in view of the cited prior art. Reconsideration and withdrawal of the rejection of the claims are therefore respectfully requested.

CONCLUSION

In view of the foregoing, it is submitted that this application is now in condition for allowance and such allowance is respectfully solicited.

Should the Examiner have any further objections or suggestions, the undersigned would appreciate a phone call or **e-mail** from the examiner to discuss appropriate amendments to place the application into condition for allowance.

Authorization is herewith given to charge any fees or any shortages in any fees required during prosecution of this application and not paid by other means to Patent and Trademark Office deposit account 50-1199.

Respectfully submitted on December 26, 2007,

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